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Original Research Article

An Observational Study Assessing the Role of Chest Radiography for Evaluation and Severity Scoring in COVID-19 Pneumonia

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Conflict of interest: Nil

Abstract

Aim: The aim of the present study was to evaluate the role of Chest Radiography for evaluation and Severity Scoring in COVID-19 Pneumonia.

Methods: The present study was conducted at the Department of Radio-diagnosis, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India, for 10 months, and 500 patients were included in the study. The study was approved by the review board of the institutions, and the requirement for informed consent was waived since the study had no risk and would not adversely affect the subjects' rights or welfare.

Results: 500 patients were retrospectively enrolled in our study. There was male predominance (60% men and 40% women). History of contact with positive patients could be traced in 50% of patients. 40% of patients in our study were clinically asymptomatic. Amongst the symptomatic group, the most common symptoms at onset were fever, cough and dyspnoea, seen in 165, 150 and 130 patients, respectively. Other less common symptoms included sore throat (4%), chest discomfort (1.8%), diarrhea (1.2%), hemoptysis (0.2%) and miscellaneous manifestations (10%). The most common comorbidity seen amongst patients was hypertension (25%), followed by diabetes mellitus (15%), chronic renal disease (3%), COPD (1.6%) and chronic liver disease (1%). 200 patients with alveolar opacities, 100 with consolidation and 50 patients with consolidations and alveolar opacities co-existent in the same radiograph were found. We also found nonspecific signs of COVID-19 pneumonia as pleural effusion, nodules and pneumothorax.

Conclusion: The features of coronavirus disease 2019 (COVID-19) on chest radiographs and proposed a severity scoring for rapid triage of patients to aid in appropriate management. As the COVID-19 pandemic threatens to overwhelm healthcare systems worldwide, highlighting the usefulness of a simple radiograph as a tool for identifying and stratifying cases of COVID-19 is justified. Determination of radiological severity can aid in effective patient categorization and enforcement of appropriate clinical management.

Keywords: COVID-19; Clinical features; Chest radiograph pattern.

Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by a novel strain of severe acute respiratory syndrome coronavirus-2 (SARS-COV-2). [1,2] The first human cases were reported in a cluster of patients in Wuhan, Hubei

province of China. [3–5] Due to a higher viral reproduction number, infectious rate and mutant nature of the viral strains, the disease transmitted rapidly out of China. The World health organization (WHO) had to eventually declare this a global pandemic. [2,6,7] Accurate stratification of disease severity at the time of disease presentation by clinical assessment and with chest radiograph is paramount in accurate allocation of resources necessary for patient care. A chest radiograph is routinely performed in the emergency department (ED) for patients presenting with symptoms of upper or lower respiratory tract infection. A recent Cochrane meta-analysis concluded that chest radiograph is moderately sensitive and moderately specific for the diagnosis of COVID-19. [8,9]

Pulmonary parenchymal disease severity is considered as a potential risk factor associated with fatal outcomes; physicians should be aware of this so as to improve the risk stratification and adjust the level of care for high-risk patients. [10,11] Several studies examined the sensitivity and specificity of CT as a semi-quantitative method to assess the severity of COVID-19 infection in the initial chest CT by implementing the CT severity scoring system, and the results were very reliable. [12] Furthermore, serial chest CT imaging with different time intervals (3-7 days) has been reported as a helpful tool in assessing the disease progression from the time of initial diagnosis till the patient's discharge. [13] Nevertheless, the dependence on CT as the only reliable radiological method to assess the severity of lung involvement is difficult to sustain over time and creates a great burden on radiology departments. [14]

Chest radiographs could serve as a substitute for CT examinations in terms of assessment of parenchymal disease severity, especially in monitoring the rapid progression of lung abnormalities in COVID-19. Some radiographic scoring systems have been tried to reduce the burden on the CT chest as a semi-quantitative method for assessment of the severity of COVID-19 infection, but none of them were properly correlated with clinical severity and CT severity scores. One of the experimental chest X-ray scoring systems (named Brixia score) was designed by Borghesi and Maroldi[15] for hospitalized patients with SARS-CoV-2 infection in Italy and was assessed on 100 hospitalized patients for whom the final outcome (recovery or death) was available. The results were very promising and led to consideration of this chest X-ray scoring system (CX-SS) as a useful parameter for predicting mortality in hospitalized patients with SARS-CoV-2 infection.

The aim of the present study was to evaluate the role of Chest Radiography for evaluation and Severity Scoring in COVID-19 Pneumonia.

Materials and Methods

The present study was conducted at the Department of Radio-diagnosis ,Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India, for 10 months, and 500 patients were included in the study. The study was approved by the review board of the institutions, and the requirement for informed consent was waived since the study had no risk and would not adversely affect the subjects' rights or welfare. Patient selection for this study was consecutive, and no exclusion criteria were applied.

Selection and description of participants:

Chest radiographs of patients with clinical-epidemiological suspicion of COVID-19 infection were performed at the ED and were retrospectively reviewed. RT-PCR nasopharyngeal-throat swabs and chest radiographs were performed immediately at the ED access, and clinical-epidemiological data was recorded for COVID-19 infection (fever, cough, dyspnea, respiratory impairment, diarrhea,

myalgia and dysgeusia). RT-PCR results were considered the reference standard. For radiological assessment, we selected only patients with RT-PCR positive results. The outcome was expressed in terms of the correlation between radiological severity and disease symptomatology. [15]

Technical information:

All chest radiographs were acquired as digital radiographs with the portable X-ray unit in the isolation wards in the posteroanterior or anteroposterior projection. All images were stored in a data portal, HMIS (Health Management Information System). [16] A retrospective review of each radiograph was performed to define the predominant pattern of COVID-19 pneumonia presentation in patients with a positive RT-PCR. Radiographic features, including consolidation, alveolar opacities, pulmonary nodules and diffuse radio-opacities, were diagnosed according to the Fleischer Society glossary of terms. [17] Moreover, chest radiographs were assessed for the presence of a specific distribution of the disease (mostly peripheral or peri hilar predominance), mono-lateral (right or left lung) or bilateral disease or diffuse predominance. All thoracic images were also assessed for evidence of other associated pulmonary pathology (pleural effusion, pneumothorax).

Radiograph scoring:

The Radiographic Assessment of Lung

Edema score (RALE score) was initially proposed by Warren et al. The radiograph was divided into four quadrants. Each quadrant was assigned a consolidation score (0 to 4) to quantify the extent of alveolar opacities and a density score (1 to 3) for more quantitative assessment of the density of opacification by quadrant. The final RALE score was the product of the consolidation and density score for each quadrant ranging from 0 (no infiltrates) to 48 (dense consolidation in >75% of each quadrant). [18]

In our study, a simplified and modified RALE score of 0-4 was assigned to each lung depending on the extent of involvement by consolidation or alveolar opacities (0, no involvement; 1, <25% involvement; 2, 25%-50% involvement; 3, 50%-75% involvement; 4, >75% involvement).The scores for each lung were summed to produce the final severity score from 0 to 8. [19]

Statistics:

Collected data were entered into Microsoft Excel software and coded. Charts and tables were prepared using Microsoft Word and Excel software. Descriptive data was presented in frequency and percentage.

The correlation between the modified RALE score and the presence of symptomatic disease was performed by Chi2 test. P value < 0.05 was considered statistically significant, and statistical software STATA version 14.2 was used for data analysis.

Results

Table 1: Demographic characteristics

Variables	N%
Age groups in years	
0-20	35 (7)
21-40	165 (35)
41-60	190 (38)
61-80	100 (20)
>80	10 (2)

Gender	
Male	300 (60)
Female	200 (40)
Asymptomatic	200 (40)
Symptomatic	275 (55)
History of contact	250 (50)
Symptoms	
Fever	165 (35)
Cough	150 (30)
Dyspnoea	130 (26)
Sore throat	20 (4)
Chest discomfort	9 (1.8)
Diarrhea	6 (1.2)
Haemoptysis	1 (0.2)
Others	50 (10)
Co-morbidities	
Hypertension	125 (25)
DM	75 (15)
Chronic renal disease	15 (3)
COPD	8 (1.6)
Chronic liver disease	5 (1)

500 patients were retrospectively enrolled in our study. There was male predominance (60% men and 40% women). History of contact with positive patients could be traced in 50% of patients. 40% of patients in our study were clinically asymptomatic. Amongst the symptomatic group, the most common symptoms at onset were fever, cough and dyspnoea, seen in 165, 150 and 130 patients, respectively. Other less common symptoms included sore throat (4%), chest discomfort (1.8%), diarrhea (1.2%), hemoptysis (0.2%) and miscellaneous manifestations (10%). The most common comorbidity seen amongst patients was hypertension (25%), followed by diabetes mellitus (15%), chronic renal disease (3%), COPD (1.6%) and chronic liver disease (1%).

Table 2: Image characteristics of SARS-CoV 2+ pneumonia on chest radiograph

Chest X-ray features	**N**	**%**
Main pattern		
Alveolar opacity	200	40
Consolidation	100	20
Alveolar opacity+ Consolidation	50	10
Diffuse GGO	35	7
Related Features		
Pleural effusion	15	3
Nodules	10	2
Pneumothorax	1	0.2
Subcutaneous emphysema	1	0.2
Others	8	1.6

200 patients with alveolar opacities, 100 with consolidation and 50 patients with consolidations and alveolar opacities co-existent in the same radiograph were found. We also

found nonspecific signs of COVID-19 pneumonia as pleural effusion, nodules and pneumothorax.

Table 3: Geographical distribution of chest X-ray changes and RALE scores

Categories	N	%
Frequency of lung involvement		
Unilateral	75	15
Bilateral	200	40
Right lung	20	4
Left lung	40	8
No. of zones affected		
0	225	45
1	35	7
2	100	20
3	10	5
4	75	15
5	10	2
6	30	6
Distribution		
Peripheral	110	22
Perihilar	10	2
Both	100	20
RALE Scores		
0-2	350	70
3-4	100	20
5-6	30	6
6-8	20	4

The unilateral disease showed left lung involvement more frequently in our study as compared to the right lung. 2 zone involvements were most commonly observed, followed by four-zone involvement.

Discussion

Radiological evaluation of patients with clinical-epidemiological suspicion of COVID-19 is indispensable, especially in the Emergency Department (ED) while waiting for RT-PCR results, to have a rapid evaluation of thoracic involvement. The recent COVID-19 radiological literature focuses primarily on Computed Tomography (CT), which is more sensitive and specific than chest radiograph. In particular, in China, CT was used as a first-line diagnostic method for COVID-19. [20] Among the various methods that exist for assessing the severity of pneumonia in COVID-19, the chest radiograph severity score is considered simple and reliable. In their original study, the authors only validated the use of chest radiograph severity scores in a younger population of adults <50 years of age. [21] Although COVID-19 has a high incidence of morbidity and mortality in older patients, it was unclear if an older age group would affect the severity score in predicting hypoxemia, requirement for intensive care unit (ICU) admission or mechanical ventilation. In this scenario, it is important to assess the diagnostic and prognostic reproducibility of admission chest radiograph severity score in all adult patients presenting to the ED.

500 patients were retrospectively enrolled in our study. There was male predominance (60% men and 40%

women). History of contact with positive patients could be traced in 50% of patients. 40% of patients in our study were clinically asymptomatic. Amongst the symptomatic group, the most common symptoms at onset were fever, cough and dyspnoea, seen in 165, 150 and 130 patients, respectively. Other less common symptoms included sore throat (4%), chest discomfort (1.8%), diarrhea (1.2%), hemoptysis (0.2%) and miscellaneous manifestations (10%). Chest radiography is widely utilized as a screening tool for detecting COVID-19 infection. However, its prognostic utility has not been validated in patients with COVID-19. The profitability of RALE scoring to aid in clinical management has been demonstrated by several other studies conducted by Cozzi D et al. Fabio Ciceri et al. Terrance C. et al etc. [22-24] It is thus recommended to expand the use of radiographs beyond its present applications, especially in resource-limited regions.

In our study, despite adjusting for age, the performance of chest radiograph severity scores remained associated with primary outcome. Furthermore, many studies have assessed the extent and severity of lung involvement at initial disease presentation for predicting outcome. A study by Kaleemi et al. used a chest X-ray severity score that was modified from the RALE score and found that increased initial chest Xray severity score was associated with ICU admission and mortality, [25] similar observation was made by Sasaki et al. that the severity of initial chest radiograph pneumonia is associated with disease severity. [26]

The most common comorbidity seen amongst patients was hypertension (25%), followed by diabetes mellitus (15%), chronic renal disease (3%), COPD (1.6%) and chronic liver disease (1%). The presence of underlying comorbidities can be reasonably suggested as drivers for worse outcomes. The study from the Centers for Disease Control and Prevention's analysis of adults <49 years of age demonstrated that underlying co-morbidities like hypertension, diabetes, obesity, asthma and immunosuppressive disease are precursors for worse outcomes in COVID-19. In our study, although hypertension was the most common comorbidity, there was no significant difference in the primary outcome, and our finding was somewhat incongruent with other reports that noted hypertension is associated with a worse prognosis in COVID-19. [27,28]

Conclusion

The features of coronavirus disease 2019 (COVID-19) on chest radiographs and proposed a severity scoring for rapid triage of patients to aid in appropriate management. As the COVID-19 pandemic threatens to overwhelm healthcare systems worldwide, highlighting the usefulness of a simple radiograph as a tool for identifying and stratifying cases of COVID-19 is justified. Determination of radiological severity can aid in effective patient categorization and enforcement of appropriate clinical management.

References

1. Hosseiny M, Kooraki S, Gholamrezanezhad A, Reddy S, Myers L. Radiology perspective of coronavirus disease 2019 (COVID-19): lessons from severe acute respiratory syndrome and Middle East respiratory syndrome. Ajr Am J Roentgenol. 2020 May 1;214(5):1078-82.
2. Nair AV, Kumar D, Yadav SK, Nepal P, Jacob B, Al-Heidous M. Utility of visual coronary artery calcification on non-cardiac gated thoracic CT in predicting clinical severity and outcome in COVID-19. Clinical Imaging. 2021 Jun 1; 74:123-30.
3. WHO. Novel Coronavirus – China. 2021.
4. Shi H, Han X, Jiang N, Cao Y, Alwalid O, Gu J, Fan Y, Zheng C.

Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study. The Lancet infectious diseases. 2020 Apr 1;20(4) :425-34.
5. Nair AV, Ramanathan S, Sanghavi P, Manchikanti V, Satheesh S, Al-Heidous M, Jajodia A, Macdonald DB. Spectrum of opportunistic fungal lung co-infections in COVID-19: What the radiologist needs to know. Radiología (English Edition). 2022 Nov 1;64(6):533-41.
6. Nair AV, McInnes M, Jacob B, Kumar D, Soman DK, Subair HS, Mahajan PS, Shah MA, Sabawi MA, Al-Heidous M. Diagnostic accuracy and inter-observer agreement with the CO-RADS lexicon for CT chest reporting in COVID-19. Emergency Radiology. 2021 Dec; 28:1045-54.
7. Nair AV, Ramanathan S, Venugopalan P. Chest imaging in pregnant patients with COVID-19: Recommendations, justification, and optimization. Acta Radiologica Open. 2022 Feb 10;11 (2): 20584601221077394.
8. ACR Recommendations for the Use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection. American College of Radiology; 2021.
9. Islam N, Ebrahimzadeh S, Salameh J-P, et al. Thoracic imaging tests for the diagnosis of COVID-19. Cochrane Database of Systematic Reviews 2021.
10. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, Xiang J, Wang Y, Song B, Gu X, Guan L. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet. 2020 Mar 28;395(10229):1054-62.
11. Chung M, Bernheim A, Mei X, Zhang N, Huang M, Zeng X, Cui J, Xu W, Yang Y, Fayad ZA, Jacobi A. CT imaging features of 2019 novel coronavirus (2019-nCoV). Radiology. 2020 Apr;295(1):202-7.
12. Yang R, Li X, Liu H, Zhen Y, Zhang X, Xiong Q, Luo Y, Gao C, Zeng W. Chest CT severity score: an imaging tool for assessing severe COVID-19. Radiology: Cardiothoracic Imaging. 2020 Mar 30;2(2): e200047.
13. Wei J, Xu H, Xiong J, Shen Q, Fan B, Ye C, Dong W, Hu F. 2019 novel coronavirus (COVID-19) pneumonia: serial computed tomography findings. Korean Journal of Radiology. 2020 Apr;21(4):501.
14. Smith DL, Grenier JP, Batte C, Spieler B. A characteristic chest radiographic pattern in the setting of the COVID-19 pandemic. Radiology: Cardiothoracic Imaging. 2020 Sep 3;2(5):e200280.
15. Borghesi A, Maroldi R. COVID-19 outbreak in Italy: experimental chest X-ray scoring system for quantifying and monitoring disease progression. La radiologia medica. 2020 May;125(5): 509-13.
16. (2020) Health Management Information System.
17. Hansell DM, Bankier AA, MacMahon H, McLoud TC, Muller NL, Remy J. Fleischner Society: glossary of terms for thoracic imaging. Radiology. 2008 Mar;246(3):697-722.
18. Warren MA, Zhao Z, Koyama T, Bastarache JA, Shaver CM, Semler MW, Rice TW, Matthay MA, Calfee CS, Ware LB. The severity scoring of lung edema on the chest radiograph is associated with clinical outcomes in ARDS. Thorax. 2018 Sep 1;73(9):840-6.
19. Wong HY, Lam HY, Fong AH, Leung ST, Chin TW, Lo CS, Lui MM, Lee JC, Chiu KW, Chung TW, Lee EY. Frequency and distribution of chest radiographic findings in patients positive for COVID-19. Radiology. 2020 Aug;296(2):E72-8.
20. Yang W, Sirajuddin A, Zhang X, Liu G, Teng Z, Zhao S, Lu M. The role of imaging in 2019 novel coronavirus pneumonia (COVID-19). European radiology. 2020 Sep; 30:4874-82.

21. Toussie D, Voutsinas N, Finkelstein M, Cedillo MA, Manna S, Maron SZ, Jacobi A, Chung M, Bernheim A, Eber C, Concepcion J. Clinical and chest radiography features determine patient outcomes in young and middle-aged adults with COVID-19. Radiology. 2020 Oct;297(1):E197-206.
22. Cozzi D, Albanesi M, Cavigli E, Moroni C, Bindi A, Luvarà S, Lucarini S, Busoni S, Mazzoni LN, Miele V. Chest X-ray in new Coronavirus Disease 2019 (COVID-19) infection: findings and correlation with clinical outcome. La radiologia medica. 2020 Aug; 125:730-7.
23. Ciceri F, Castagna A, Rovere-Querini P, De Cobelli F, Ruggeri A, Galli L, Conte C, De Lorenzo R, Poli A, Ambrosio A, Signorelli C. Early predictors of clinical outcomes of COVID-19 outbreak in Milan, Italy. Clinical immunology. 2020 Aug 1; 217:108509.
24. Hui TC, Khoo HW, Young BE, Mohideen SM, Lee YS, Lim CJ, Leo YS, Kaw GJ, Lye DC, Tan CH. Clinical utility of chest radiography for severe COVID-19. Quantitative imaging in medicine and surgery. 2020 Jul;10(7):1540.
25. Kaleemi R, Hilal K, Arshad A, Martins RS, Nankani A, Tu H, Basharat S, Ansar Z. The association of chest radiographic findings and severity scoring with clinical outcomes in patients with COVID-19 presenting to the emergency department of a tertiary care hospital in Pakistan. PloS one. 2021 Jan 5;16(1):e0244886.
26. Sasaki H, Kawano S, Ota S, Taniguchi H, Kodama T, Obinata H, Tamura K, Ito T, Uwabe Y. Efficacy of chest radiography as a primary care triage tool in severe coronavirus disease. Internal Medicine. 2021 Sep 15;60 (18):2911-7.
27. Garg S, Kim L, Whitaker M, O'Halloran A, Cummings C, Holstein R, Prill M, Chai SJ, Kirley PD, Alden NB, Kawasaki B. Hospitalization rates and characteristics of patients hospitalized with laboratory-confirmed coronavirus disease 2019—COVID-NET, 14 States, March 1–30, 2020. Morbidity and mortality weekly report. 2020 Apr 4;69(15):458.
28. Yeganeh. Studying the effect of spironolactone treatment on right ventricular function in patients with pulmonary hypertension group 1. Journal of Medical Research and Health Sciences, 2023; 6(2): 2450–2456.